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Pacific Islands Fisheries Science Center

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GEOGRAPHIC PATTERNS OF FORAGING DISPERSION OF HAWAIIAN MONK SEALS (*Monachus schauinslandi*) IN THE NORTHWESTERN HAWAIIAN ISLANDS

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PREFACE

This report has been sponsored by the Pacific Islands Fisheries Science Center and provides the results of recent research efforts to ascertain the habitat use and foraging ecology of Hawaiian monk seals in the Northwestern Hawaiian Islands (NWHI). This work is a part of a research project involving a synthesis of all data available on the foraging behavior of Hawaiian monk seals in the NWHI. Subsequent publications of these results will involve a more thorough comparative analysis and interpretation of variation in individual and colony behaviors relative to variation in biotic and abiotic characteristics of marine habitats throughout the NWHI marine ecosystem.

This report was funded by contract AB133F-03-CN-0008. Because this report was prepared by an independent investigator, its statements, findings, conclusions, and recommendation do not necessarily reflect the official views of the National Marine Fisheries Service, NOAA, U.S. Department of Commerce.

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Introduction

Hawaiian monk seals (*Monachus schauinslandi*) are endemic to the Hawaiian Island Archipelago with most of the metapopulation living at six relatively remote atolls and islands in the Northwestern Hawaiian Islands (NWHI; Fig. 1), though increasing numbers of seals and births have been observed in the main Hawaiian Islands (MHI) in the past decade (Baker and Johanos, 2004).

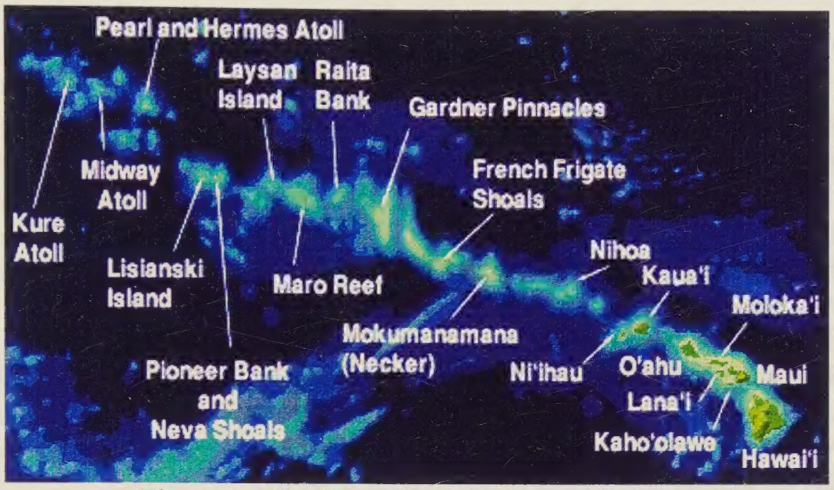

Figure 1. The Hawaiian Islands Archipelago.

Owing to substantial population decline of the monk seal metapopulation between 1950 and 1970, the species was listed as *Endangered* in November 1976 (U.S. Department of Commerce 1976) under the U.S. Endangered Species Act (16 U.S.C. § 1531 *et seq.*). Based on considerations of breeding habitats and sparse information on foraging habitats (DeLong *et al.*, 1984), *Critical Habitat* was defined in April 1986 (U.S. Department of Commerce, 1986a, 1986b) to include waters seaward of the breeding sites to 10 fathom depths. *Critical Habitat* was subsequently extended in May 1988 (U. S. Department of Commerce, 1988), based on a few additional records of diving patterns (Schlexer, 1984), to include waters out to 20 fathom depths at those sites and others.

Hawaiian monk seals evidently spend around two-thirds of their lives in the marine environment. Until recently relatively little was known about particular marine habitats that may be critical to their foraging success, yet that information is vital for making management decisions to ensure the vitality of the remaining small populations and their recovery as described in the NOAA Fisheries Strategic Plan (1997). Indeed, a comprehensive understanding of the diet and foraging habitats and patterns has been identified as a key component for successful conservation of Hawaiian monk seals and for resolving substantive and procedural issues involved in shared use of marine resources in the Hawaiian Islands Archipelago. Consequently, NOAA Fisheries supported studies from 1996 through 2002 to characterize the foraging habitats of Hawaiian monk seals at each of the colonies in the Northwestern Hawaiian Islands (NWHI), through the use of ARGOS satellite technology and telemetry instruments (Abernathy and Siniff, 1998; Stewart, 1998, 1999; Stewart and Yochem, 2002a, 2002b, 2003). The key objective of those studies was to characterize the marine and terrestrial

habitat requirements of Hawaiian monk seals throughout their range. The inductive research approach was aimed at allowing evaluation of the hypothesis that declines in birth rates and survival of pups and juveniles, and increases in age of first reproduction of females may be causally connected to reductions in prey resources (owing to either human activities or natural environmental changes [punctuated events and trends], or both, having cascading or directional effects on community structure). The purpose of this report is to summarize the general foraging dispersions of Hawaiian monk seals in the NWHI from previous studies at individual colonies.

Summary of foraging dispersion

From 1996 through 2002, the movements and dive patterns of 147 Hawaiian monk seals (41 adult males, 35 adult females, 29 juvenile males, 15 juvenile females, 12 weaned male pups, 15 weaned female pups; Abernathy, 1999; Abernathy and Siniff, 1998; Stewart, 1998; Stewart and Yochem 2002a, 2002b, 2003) were monitored for several months or more with data-recording, satellite-linked radio transmitters glued to their dorsal pelage (Table 1).

Seals foraged extensively within the fringing atoll lagoons at French Frigate Shoals, Pearl and Hermes Reef, Midway Atoll, and Kure Atoll, and on the outer slopes of those atolls and seaward of Laysan and Lisianski Island (Figs. 2, 3, 4). Seals also ranged to and evidently foraged along the submarine ridges between those atolls and islands and at virtually all nearby seamounts (Figs. 5, 6, 7, 8, 9, 10).

Generalized foraging ranges varied to various extents by age and sex of seals and also among colonies (Figs. 11, 12, 13, 14, 15, 16). Though there were substantial overlaps in the generalized foraging ranges of those groups at each colony, it also appears that seals segregated while foraging at all colonies (Figs. 17, 18, 19, 20, 21, 22). Distances that seals traveled to forage from haul-out and breeding sites also varied with seals' age and sex and with colony of seal origin (either birth site or primary haul-out site during the studies; Abernathy, 1999; Stewart, 1998; Stewart and Yochem, 2002a, 2002b, 2003).

The geographic habitats that Hawaiian monk seals use while foraging in the NWHI may vary temporally and spatially with the variation in the physical characteristics of atoll, seamount, and island structure, physical substrate, prey community composition and species' abundance, and demographic composition of monk seals at the colonies. Further statistical analyses of these geographic patterns of foraging dispersion, dive patterns, and the physical and oceanographic characteristics of the NWHI marine ecosystem should allow evaluation of testing of those hypotheses and a more informed assessment of the key factors that may be limiting and regulating the demography and population abundance of the Hawaiian monk seal metapopulation.

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U.S. Department of Commerce. 1988. Critical Habitat; Hawaiian monk seal; Endangered Species Act. 53 FR 18988.Table 1. Hawaiian Monk seals monitored with satellite-linked data recorders and radio transmitters from 1996 through 2002 at the Northwestern Hawaiian Islands to document the extent of marine habitats (geographic and vertical spatial scales) used while foraging.

Colony	Males				Females				TOTAL
	Adults	*Juveniles*	*Weaned pups*	*Total*	*Adults*	*Juveniles*	*Weaned pups*	*Total*	
French Frigate Shoals[1] *(1996-1997)*	17	0	0	***17***	10	0	0	***10***	**27**
Laysan Island[2] *(2001-2002)*	5	5	5	***15***	5	5	5	***15***	**30**
Lisianski Island[3] *(2000-2001)*	4	7	4	***15***	5	2	4	***11***	**26**
Pearl & Hermes Reef[4] *(1997-1998)*	9	5	0	***14***	9	1	0	***10***	**24**
Midway Islands[5] *(2000-2001)*	2	5	2	***9***	2	3	2	*7*	**16**
Kure Atoll[6] *(2001-2002)*	4	7	1	***12***	4	4	4	***12***	**24**
TOTAL	**41**	**29**	**12**	***82***	**35**	**15**	**15**	***65***	**147**

[1] Abernathy and Siniff (1998); Abernathy (1999)
[2] Stewart and Yochem (2001b, 2002)
[3] Stewart and Yochem (2000, 2003)
[4] Stewart (1998)
[5] Stewart and Yochem (2001b, 2003)
[6] Stewart and Yochem (2001c, 2002b)

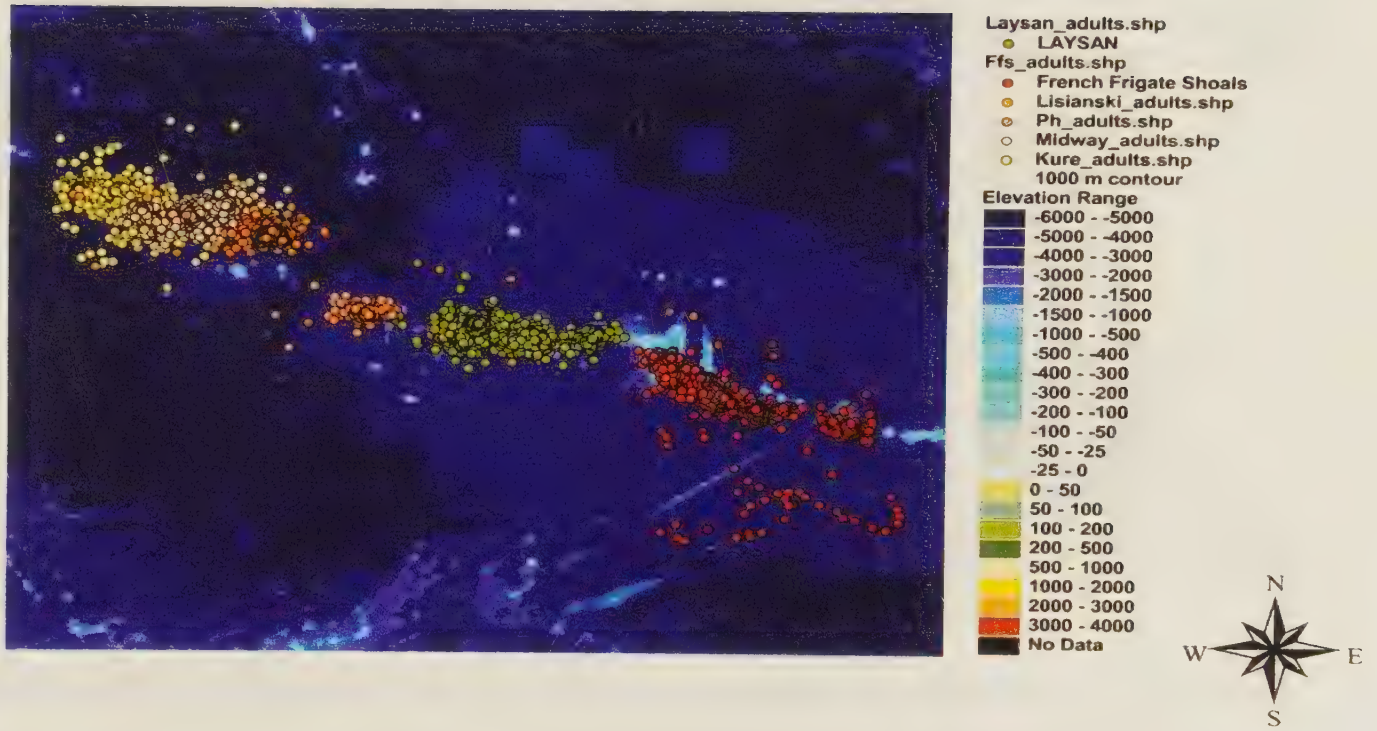

Figure 2. Foraging dispersion of adult Hawaiian monk seal in the northwestern Hawaiian Islands.

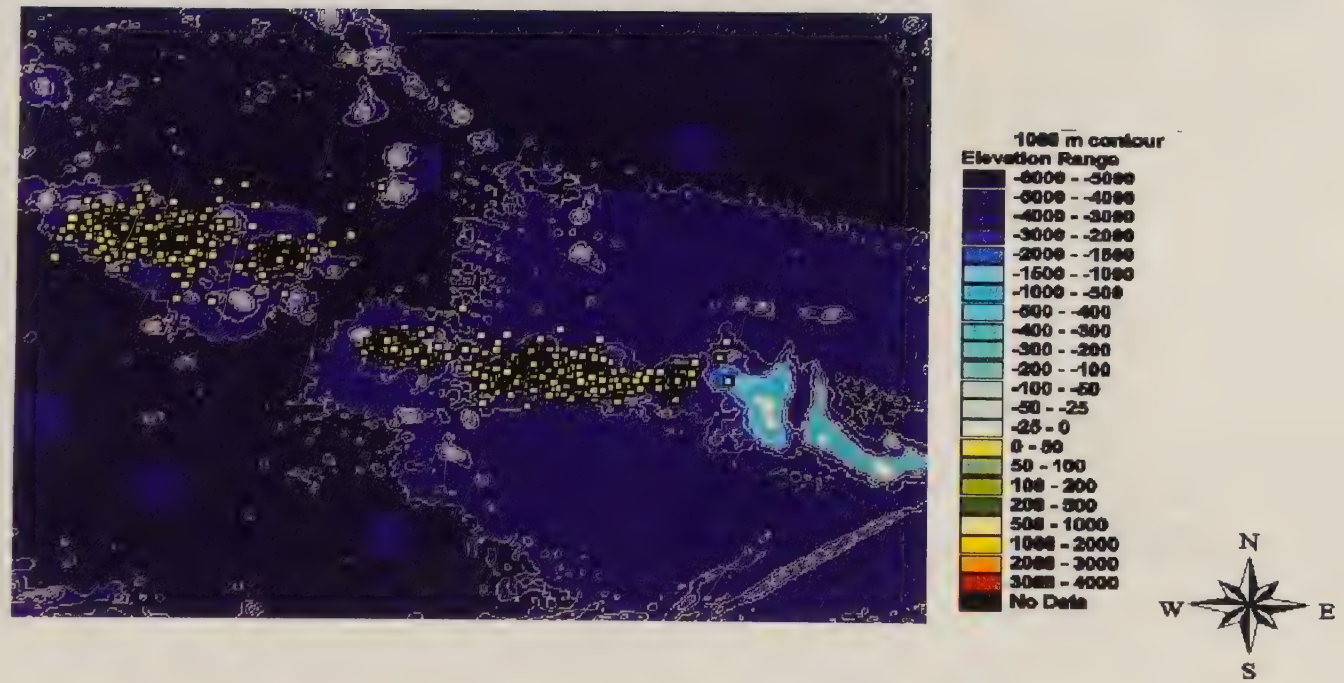

Figure 3. Foraging dispersion of juvenile Hawaiian monk seals in the northwestern Hawaiian Islands.

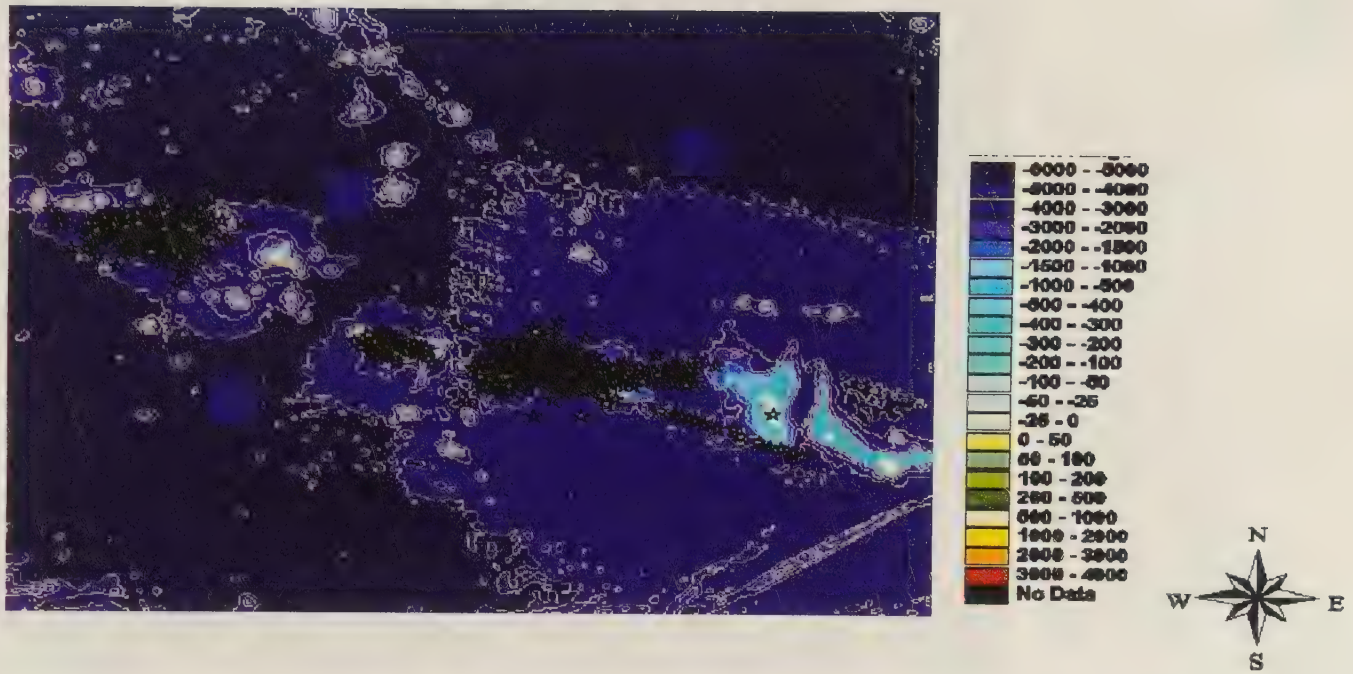

Figure 4. Foraging dispersion of weaned Hawaiian monk seal pups in the northwestern Hawaiian Islands.

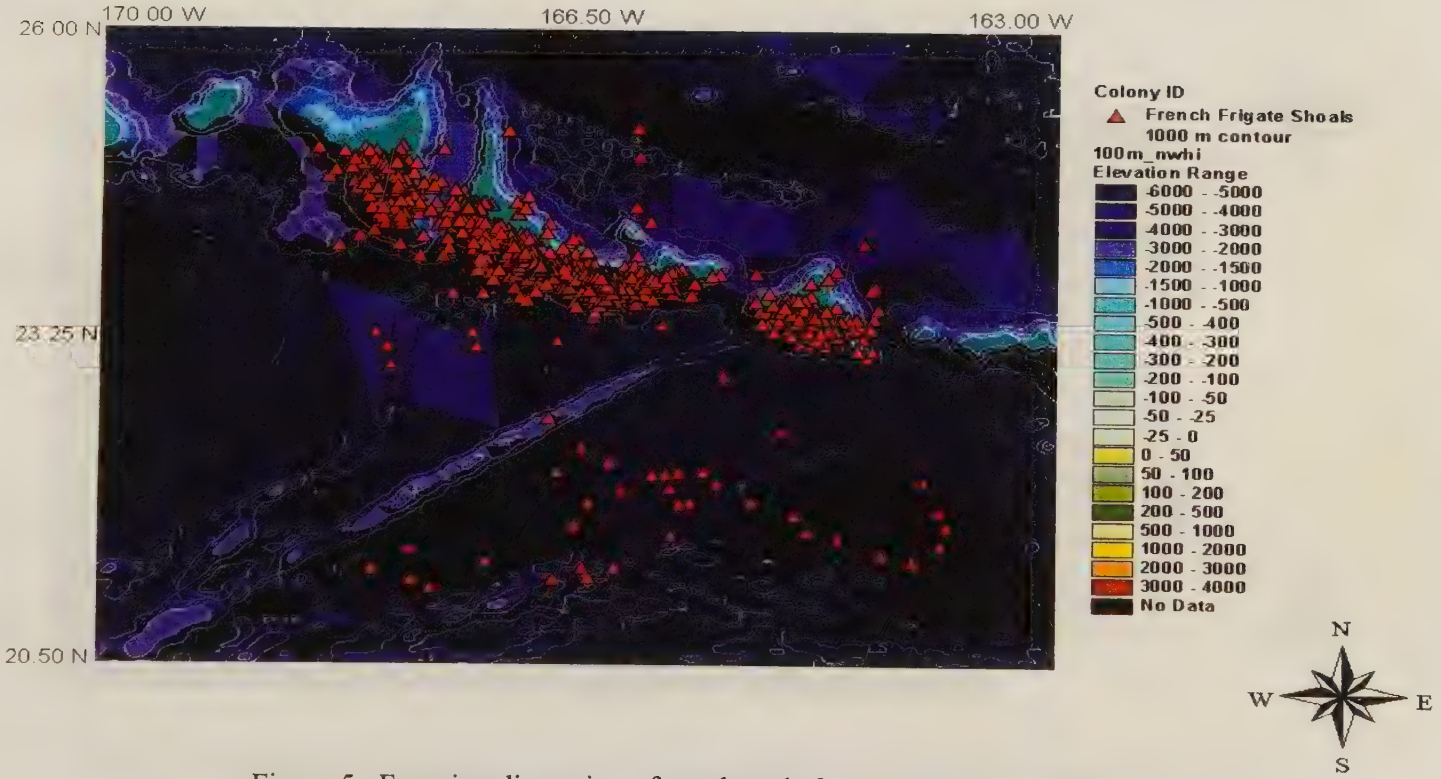

Figure 5. Foraging dispersion of monk seals from French Frigate Shoals.

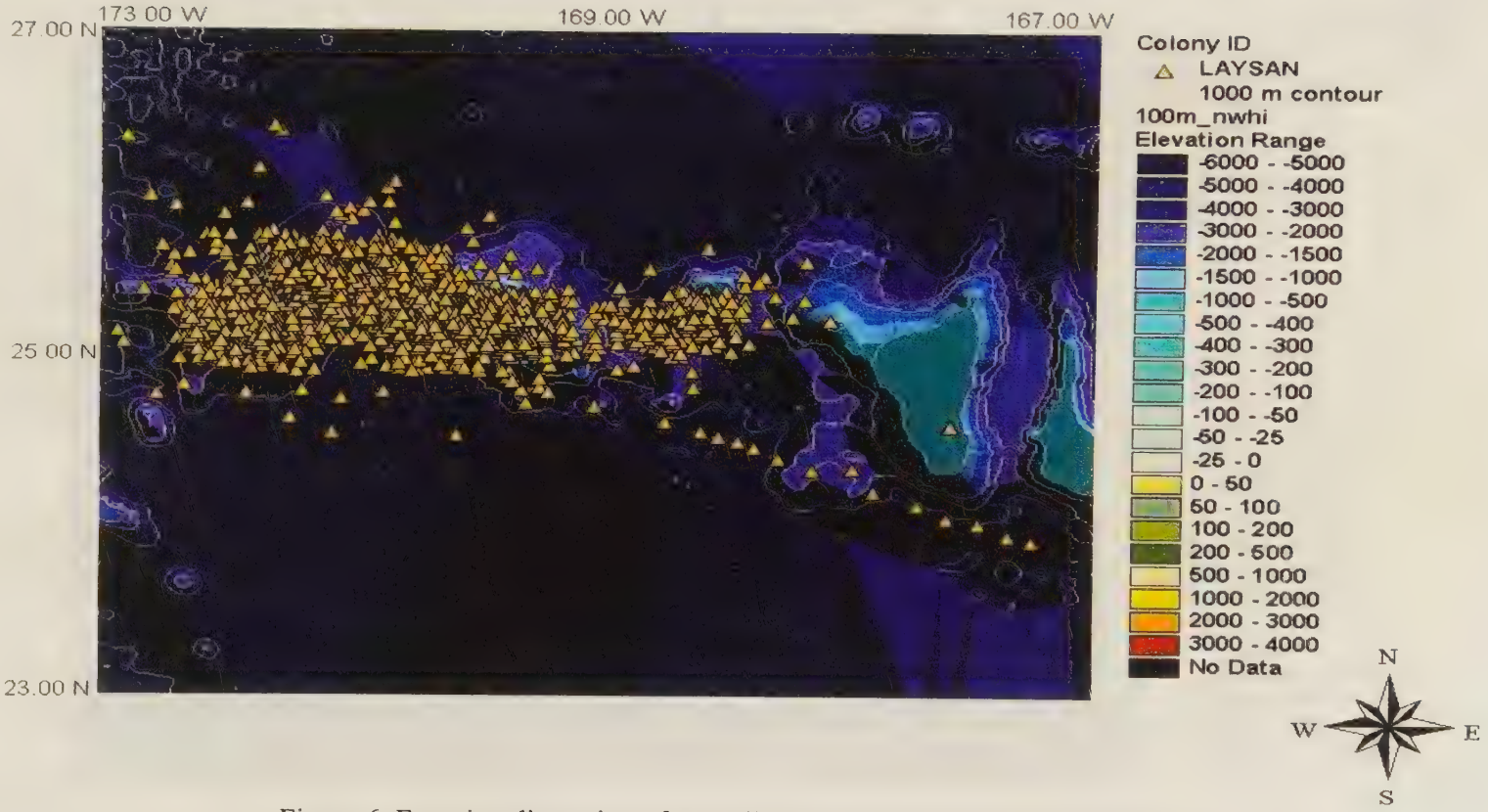

Figure 6. Foraging dispersion of Hawaiian monk seals from Laysan Island.

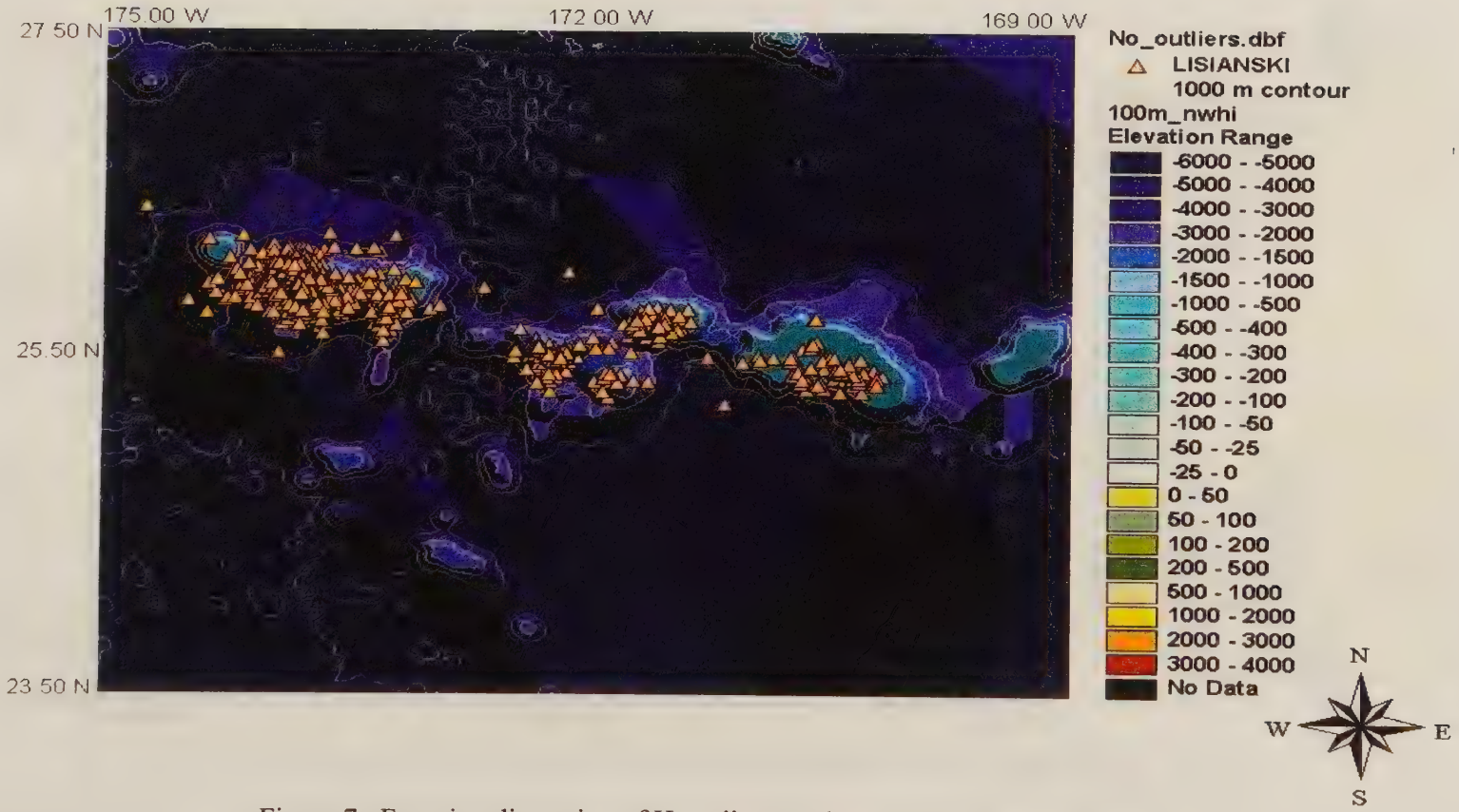

Figure 7. Foraging dispersion of Hawaiian monk seals from Lisianski Island.

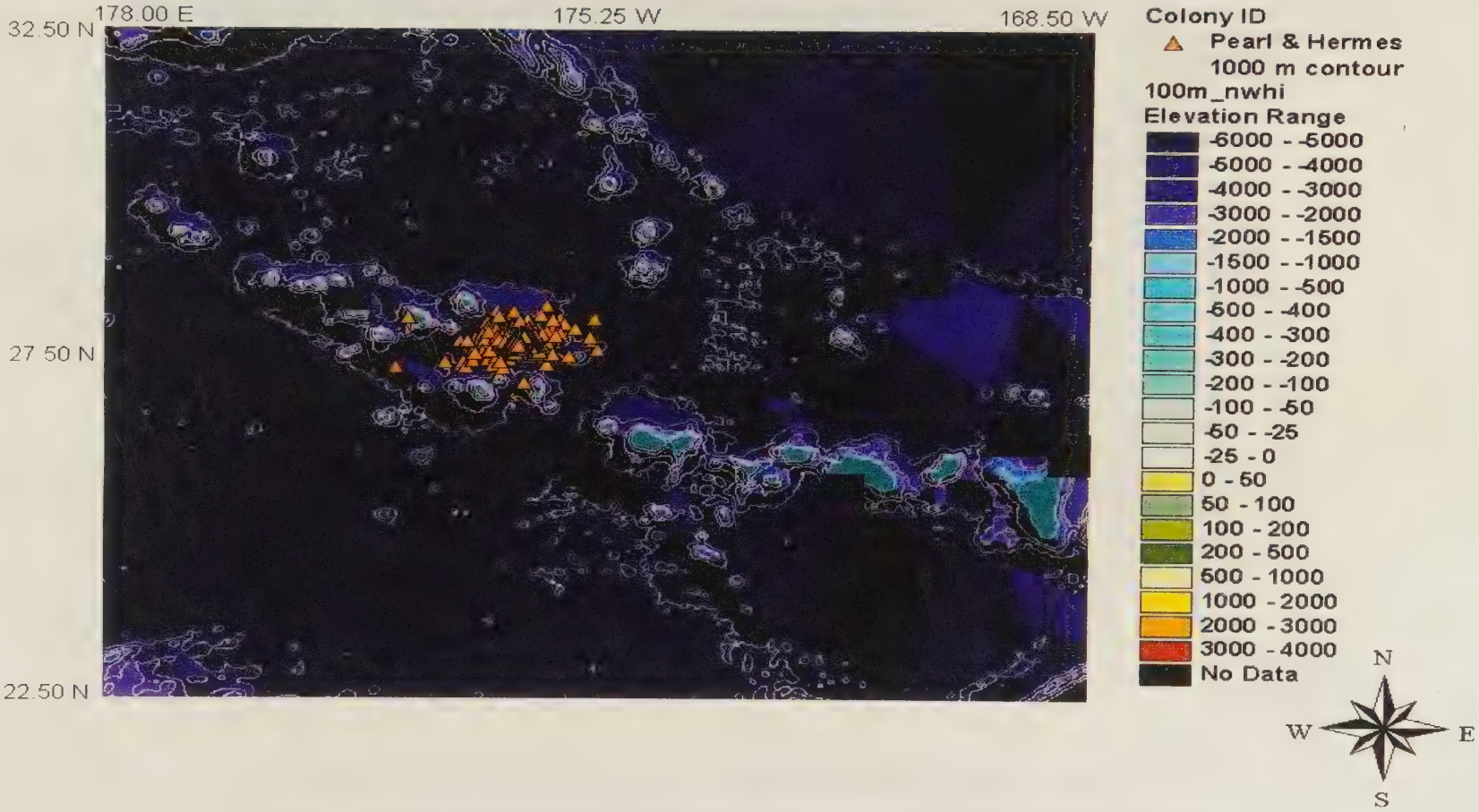

Figure 8. Foraging dispersion of Hawaiian monk seals from Pearl and Hermes Reef.

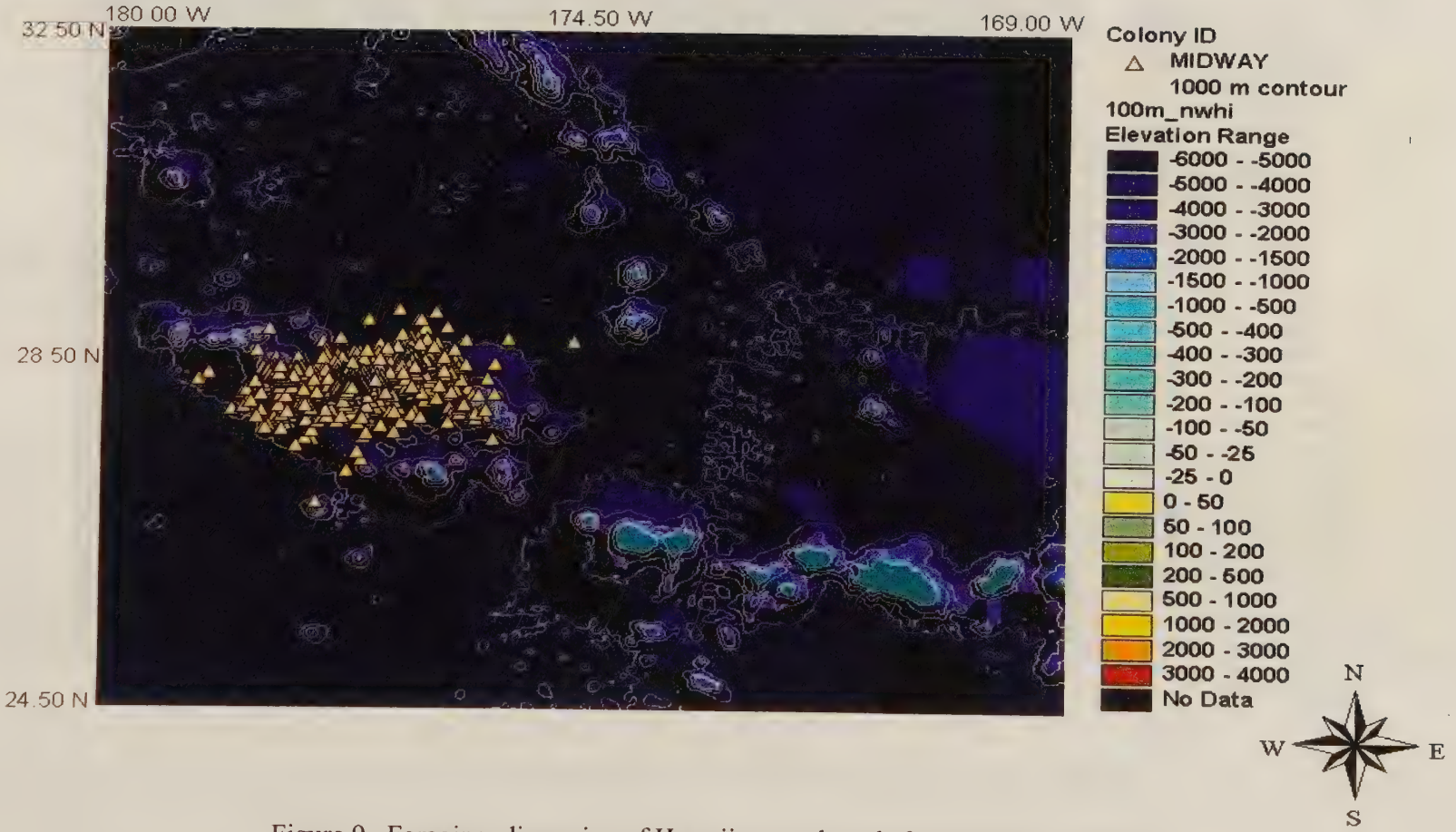

Figure 9. Foraging dispersion of Hawaiian monk seals from Midway Islands.

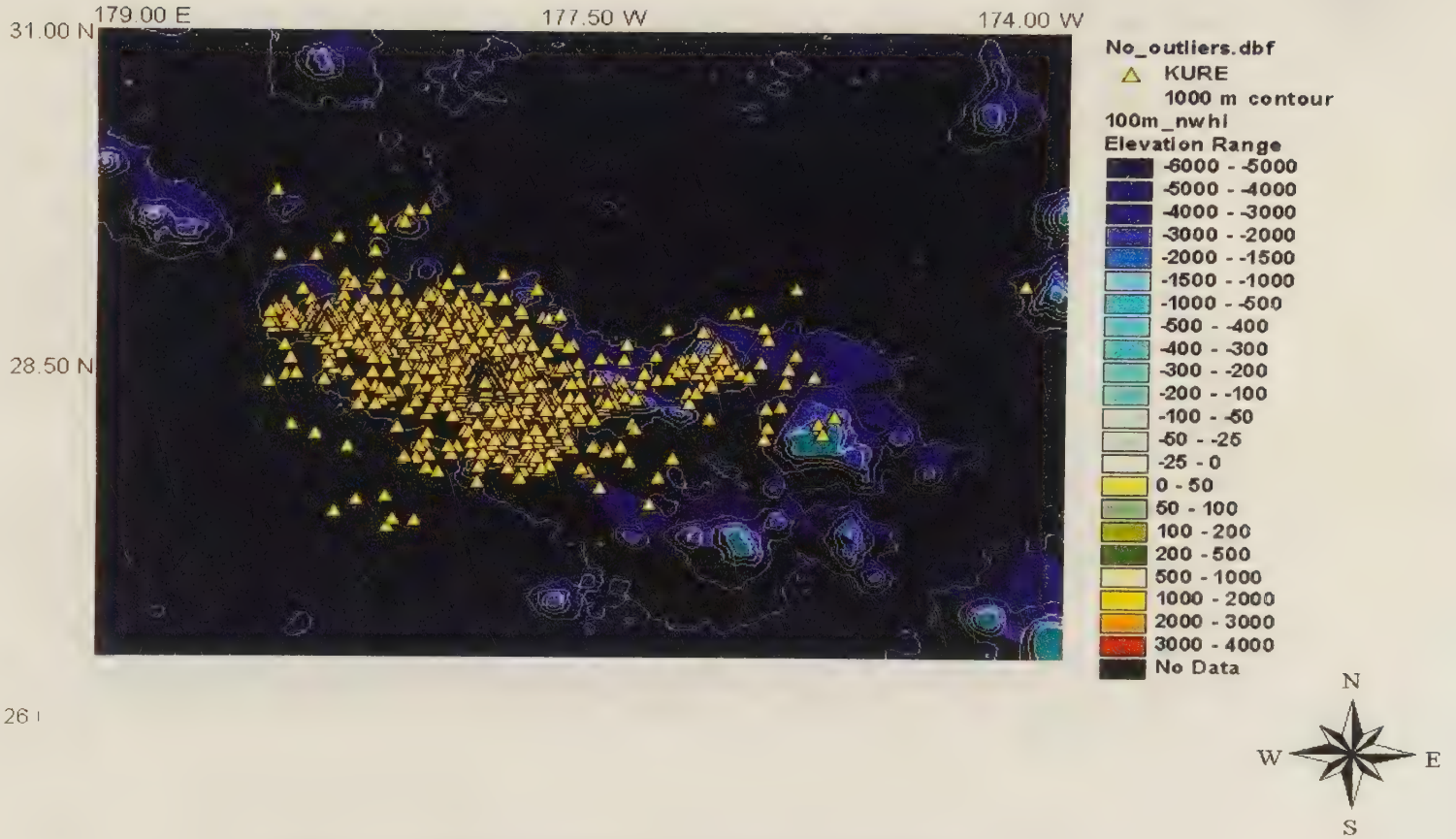

Figure 10. Foraging dispsersion of Hawaiian monk seals from Kure Atoll.

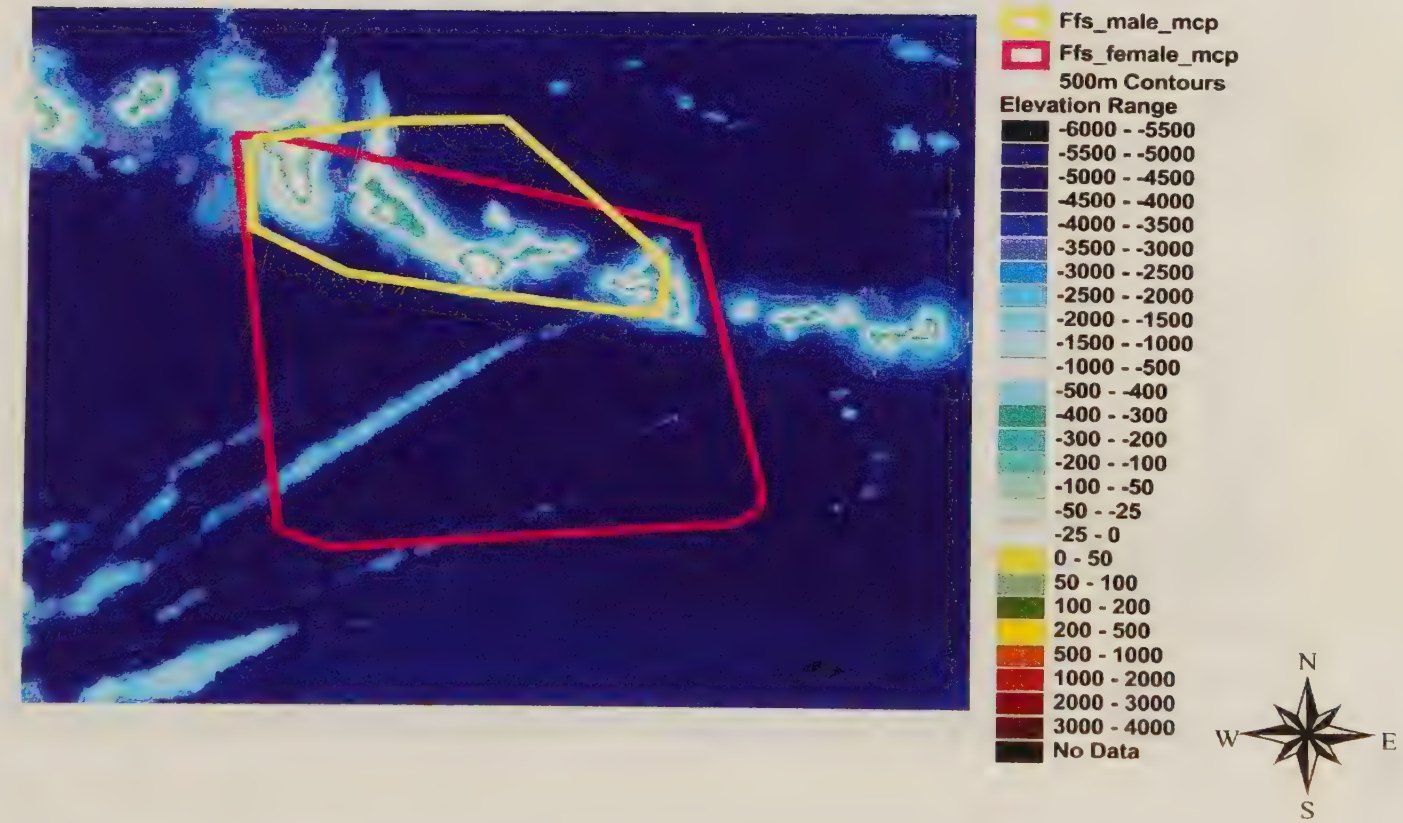

Figure 11. Generalized foraging ranges of Hawaiian monk seals from French Frigate Shoals.

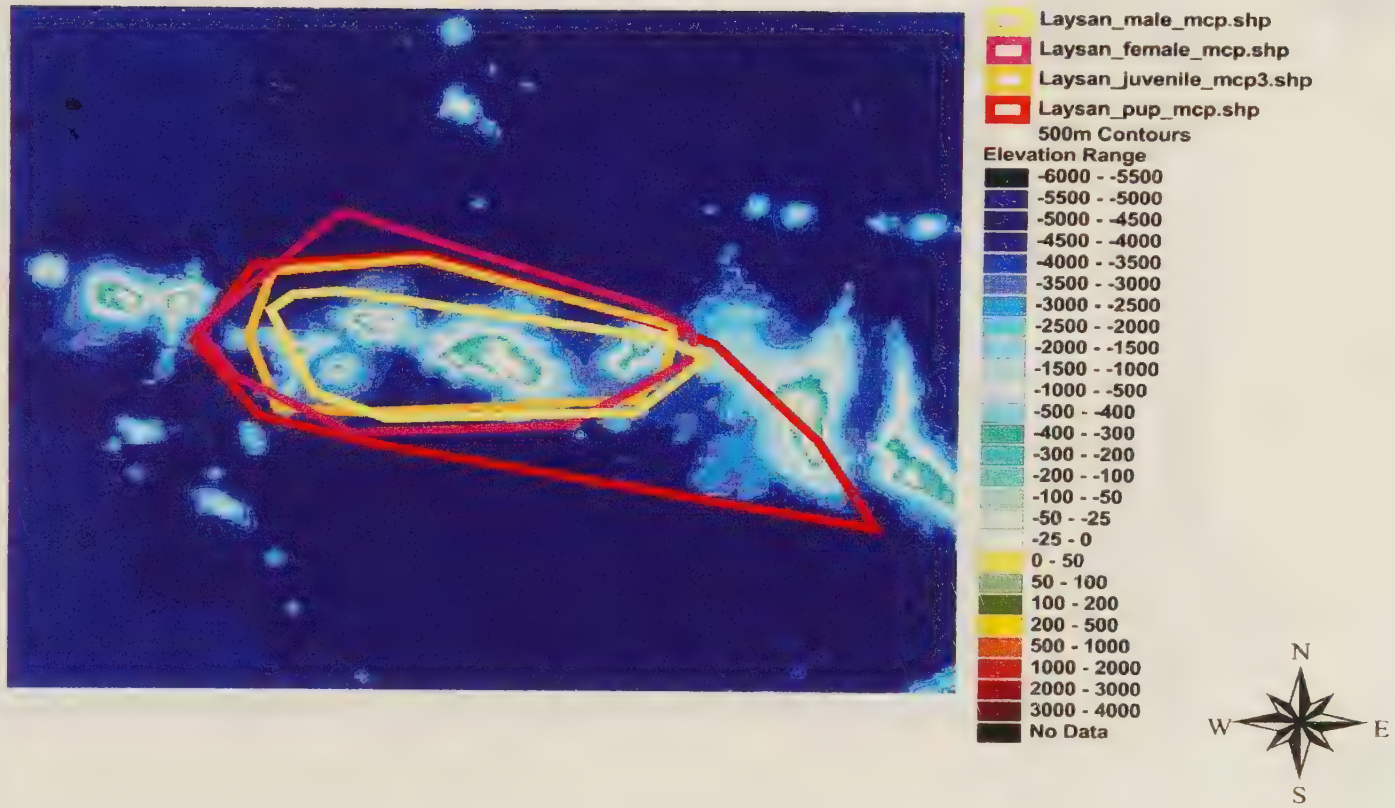

Figure 12 . Generalized foraging ranges of Hawaiian monk seals from Laysan Island.

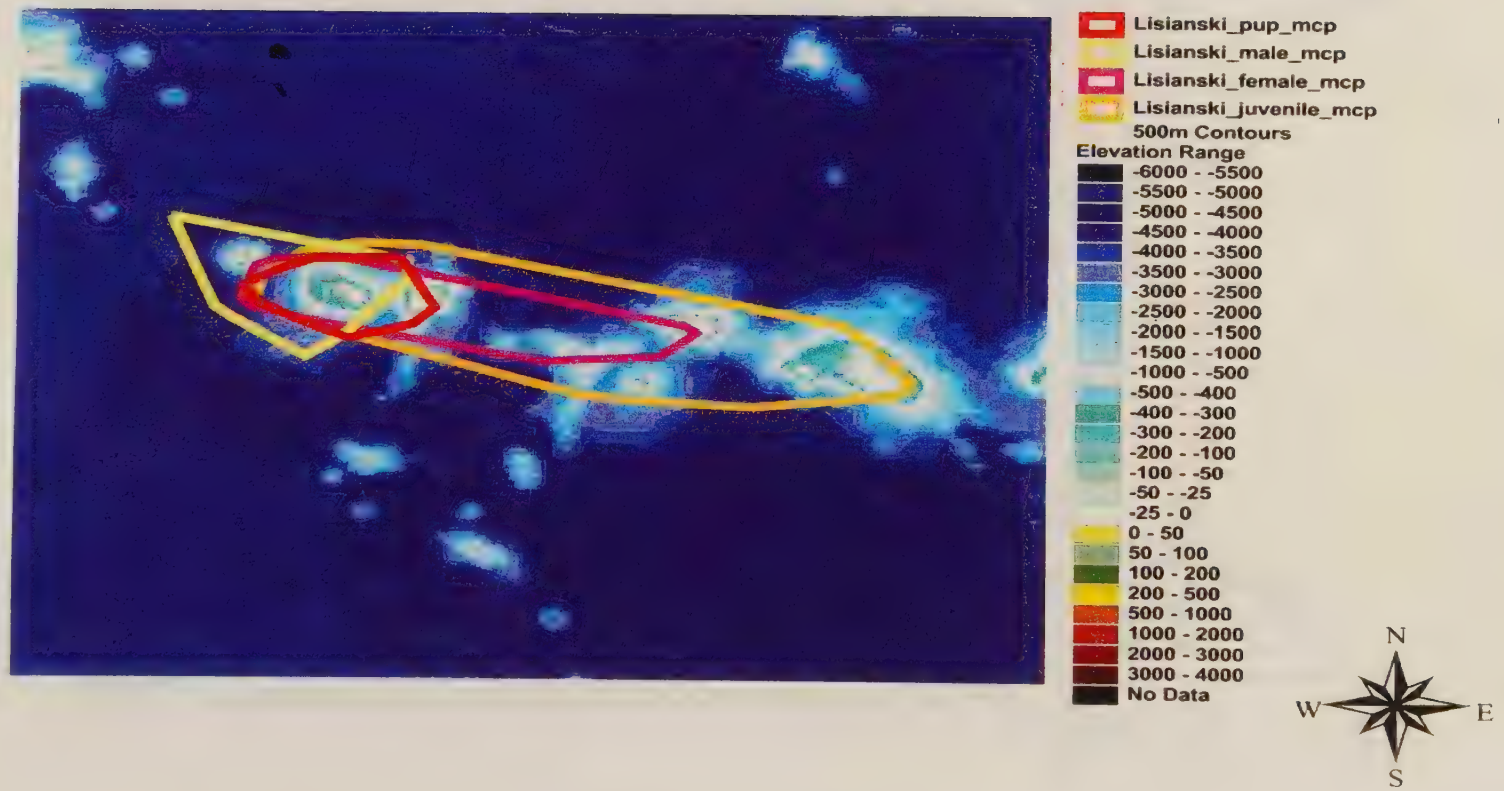

Figure 13. Generalized foraging ranges of Hawaiian monk seals from Lisianski Island.

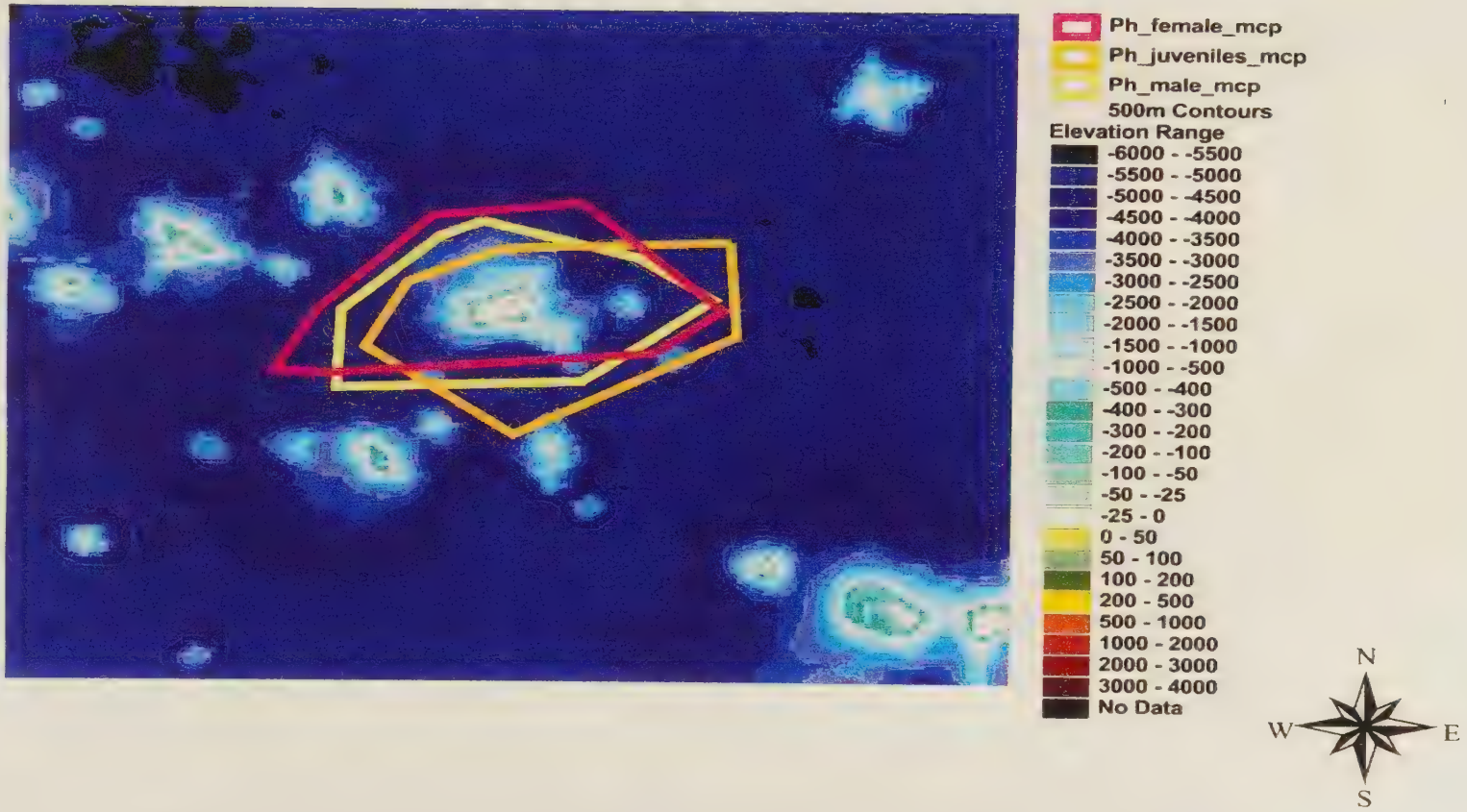

Figure 14. Generalized foraging ranges of Hawaiian monk seals from Pearl and Hermes Reef.

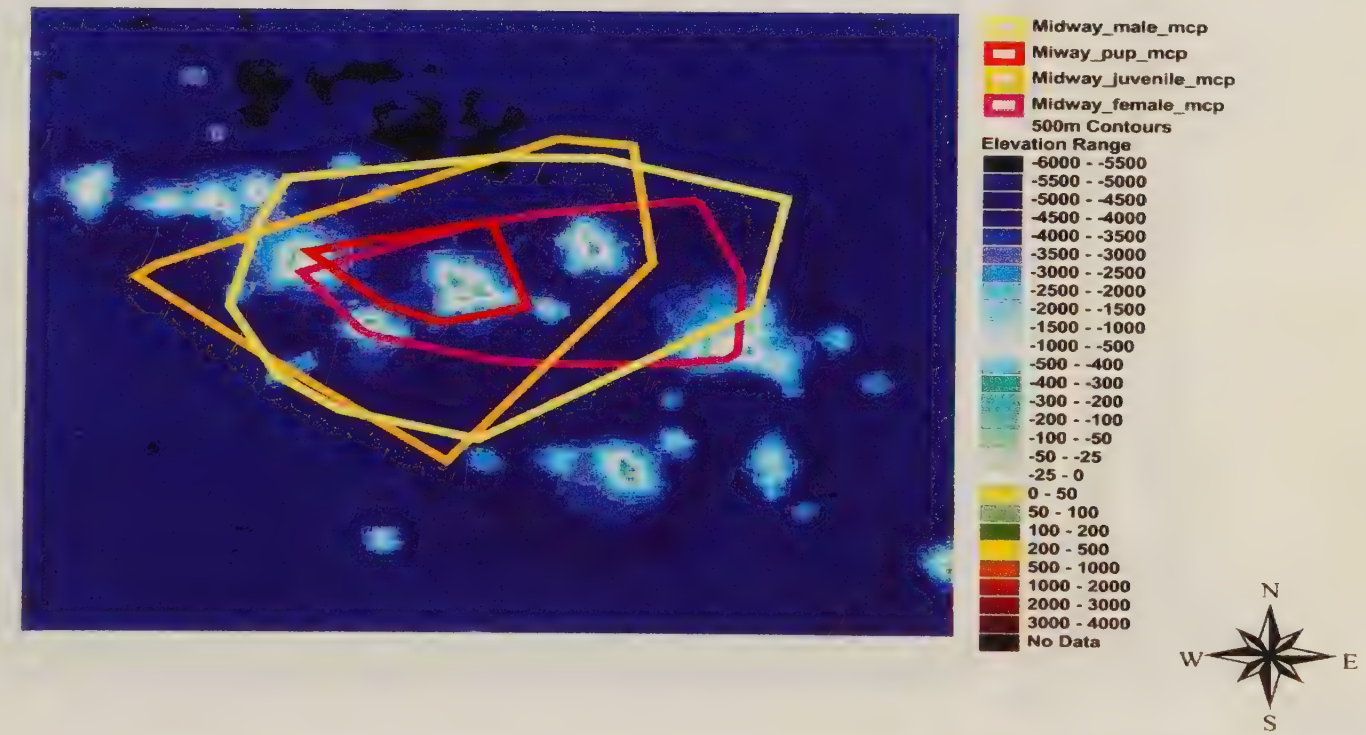

Figure 15. Generalized foraging ranges of Hawaiian monk seals from Midway Islands.

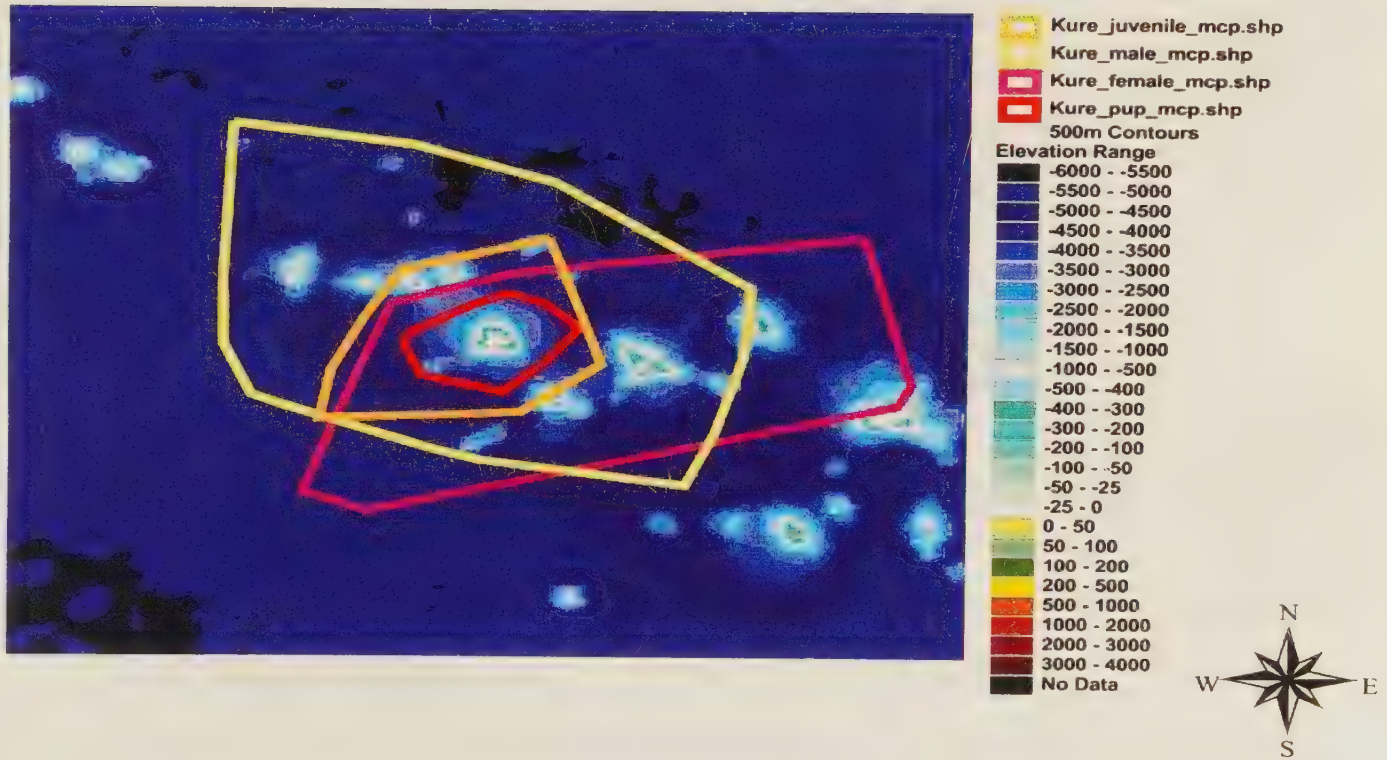

Figure 16. Generalized foraging ranges of Hawaiian monk seals from Kure Atoll.

Figure 17. Variation in foraging dispersion among Hawaiian monk seals at French Frigate Shoals.

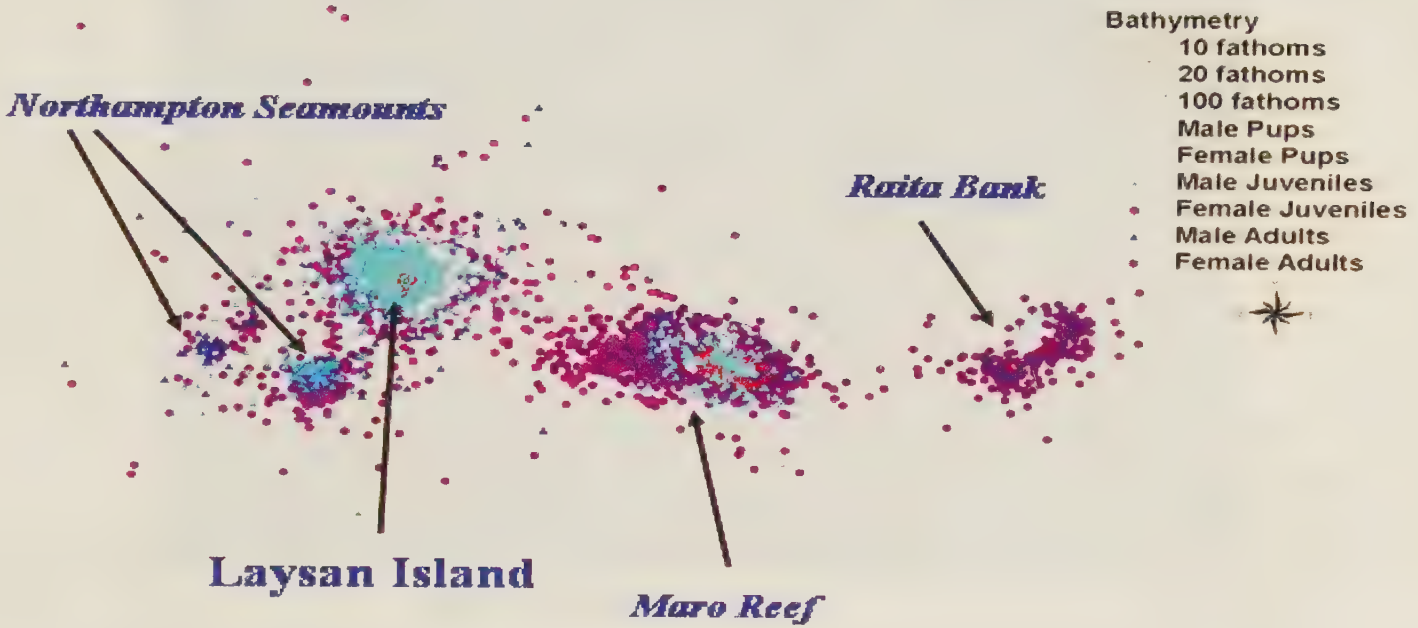

Figure 18. Variation in foraging dispersion among Hawaiian monk seals from Laysan Island.

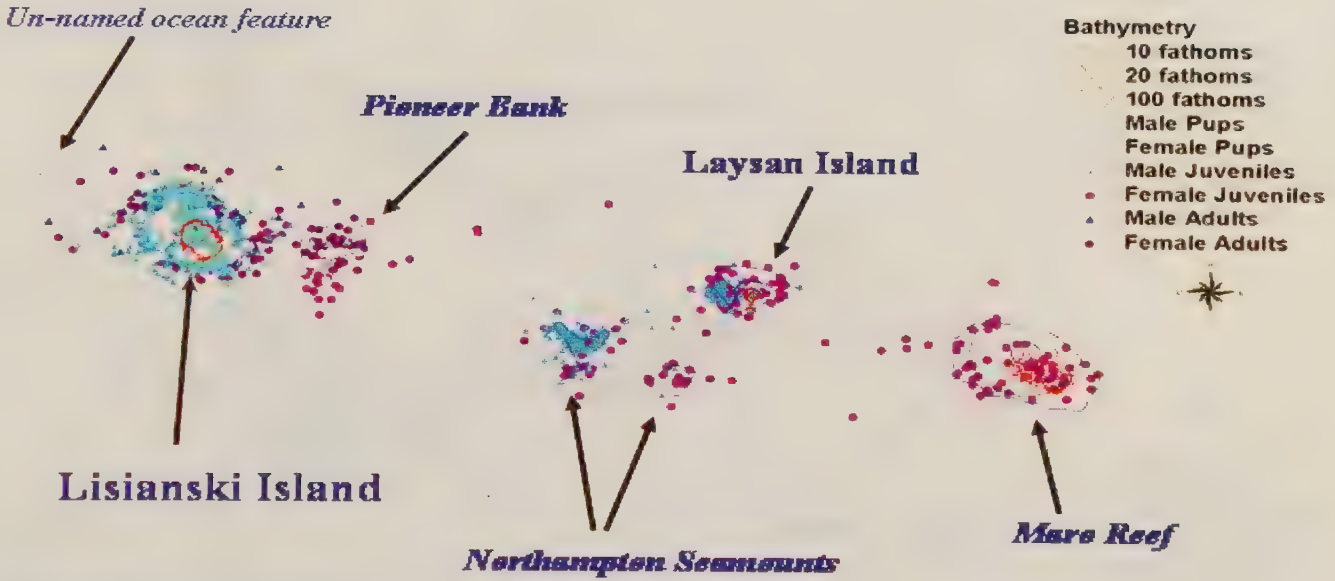

Figure 19. Variation in foraging dispersion among Hawaiian monk seals from Lisianski Island.

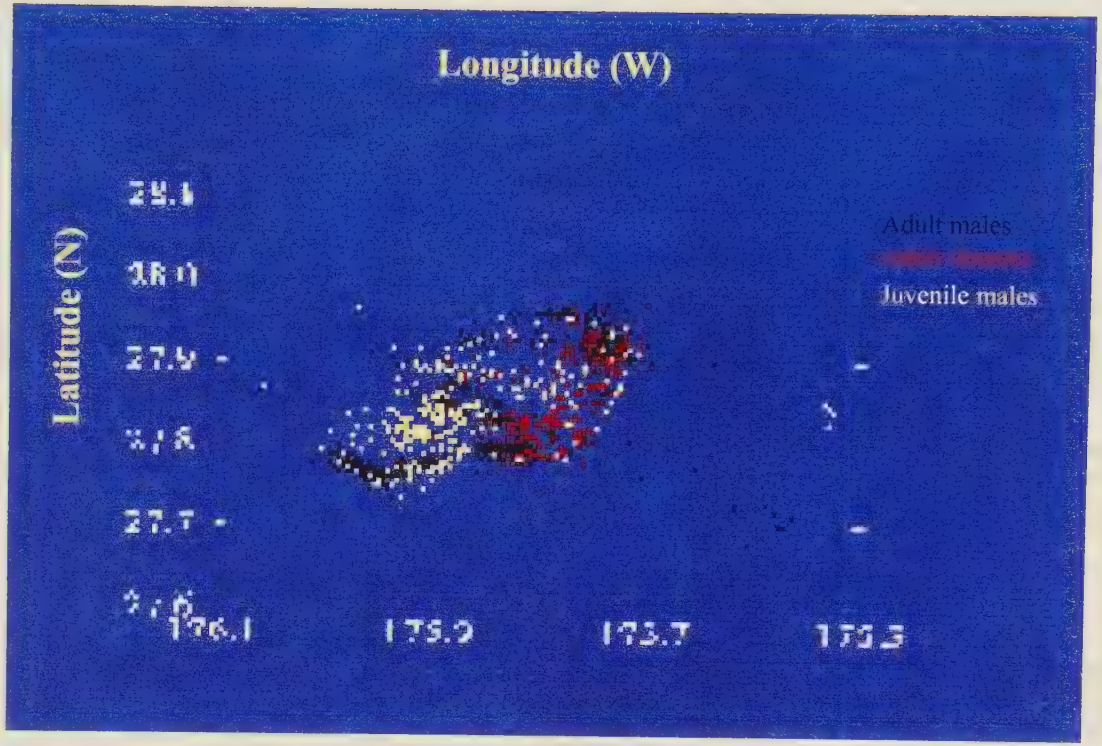

Figure 20. Variation in foraging dispersion among Hawaiian monk seals at Pearl and Hermes Reef.

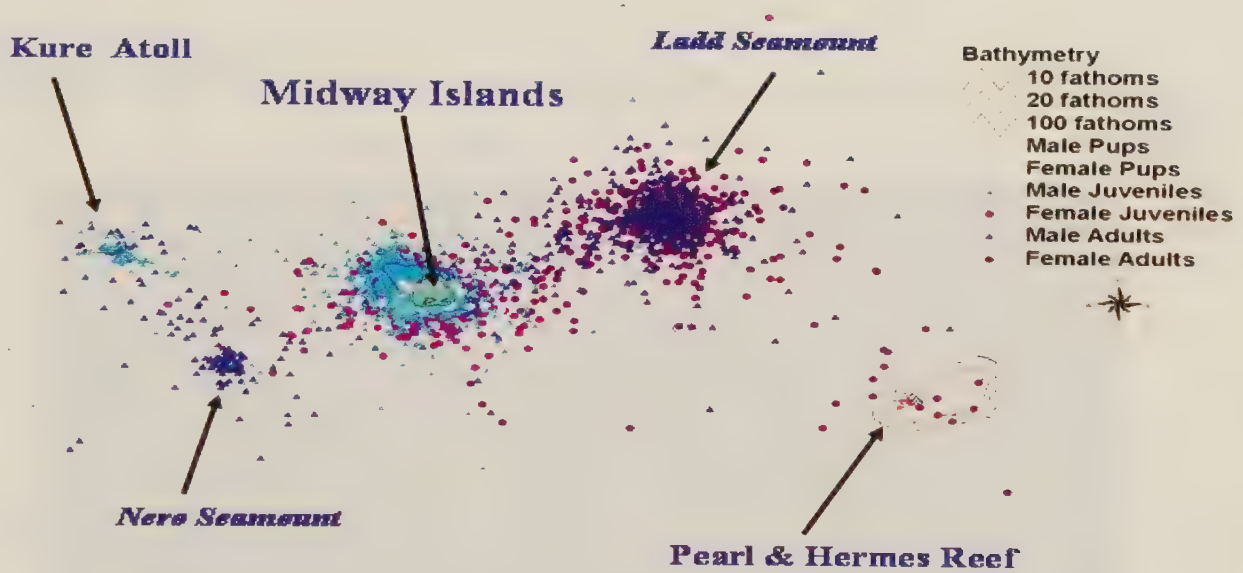

Figure 21. Variation in foraging dispersion among Hawaiian monk seals at Midway Islands.

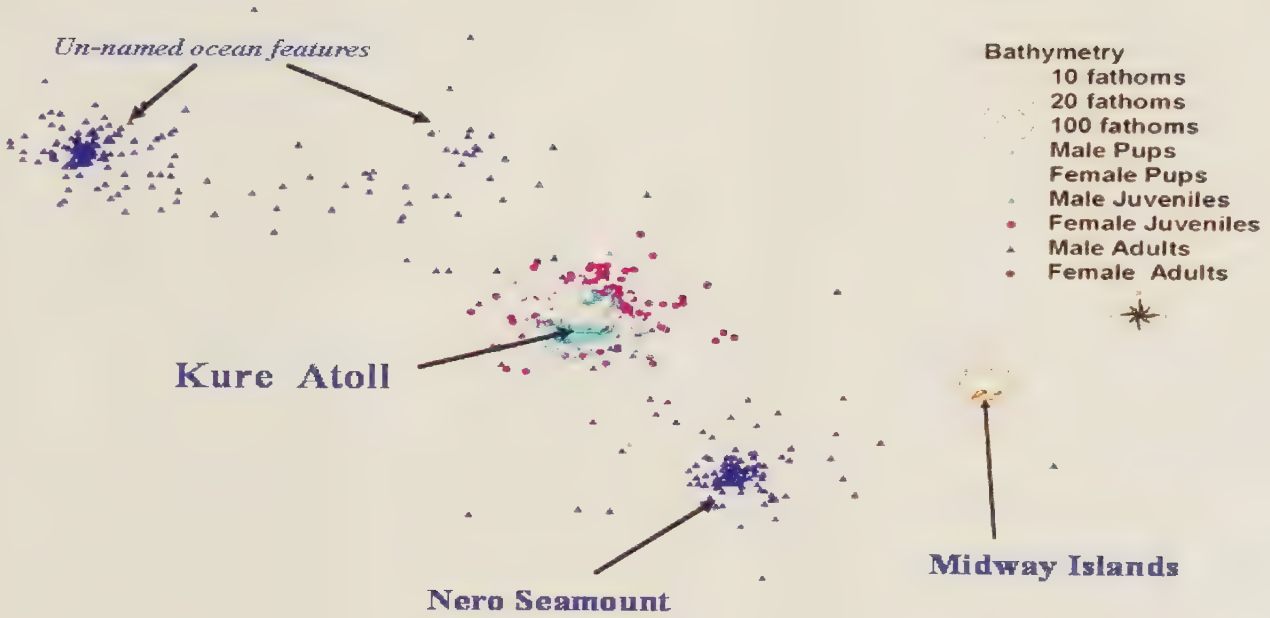

Figure 22. Variation in foraging dispersion among Hawaiian monk seals from Kure Atoll.

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